The second death of Schrödinger's cat or the paradox of simultaneity in SRT

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Abstract

The logical-pragmatic analysis [1, 2] of the concept of "time" in the special theory of relativity leads to a logically insoluble paradox of simultaneity in SRT, associated with two ways of clock synchronization in inertial frames of reference.

The first, usual way, when time is interpreted as the duration of some physical process - the propagation of light, does not lead to a paradox.

The second way - any way of synchronizing two clocks spaced apart in space, excluding any reference physical process (which is quite acceptable in a thought experiment), leads to a paradox when a cat is alive in one inertial frame, and the same cat is dead in another.

The paradox is logically unreasonable, since according to the synchronization condition of the second method, any physical objection (argument), up to Lorentz transformations, is logically put out of consideration. Since all such arguments are based on the first method of clock synchronization.

The author puts forward a hypothesis about a new connection between reality and consciousness, which can only be confirmed or falsified experimentally.

1 The second death of Schrödinger's cat or an introduction to the problem

It is usually **believed that in the special theory of relativity** (SRT) all "paradoxes" *associated* with the representation of reality as a system of events (time - t and place - x, y, z) in 4-dimensional space follow from the fundamental postulate of the constancy of the speed of light in all inertial frames of reference.

I will try to show here that behind this postulate lies an even more fundamental assumption, which is the real source of the SRT paradoxes, and the postulate of the constancy of the speed

of light is only a particular technical way of its implementation.

Einstein, introducing the concept of an inertial frame of reference as a uniformly and rectilinearly moving material system with a constant speed, added to it a method of clock synchronization, which made the inertial frame a frame of reference.

The logical meaning of clock synchronization hides the very assumption that I have already mentioned. Namely, that time (t) for SRT is just a technical way of measuring it, and nothing else, on the basis of one or another physical phenomenon, in our case, the propagation of light in a vacuum.

To demonstrate this, I will consider two versions of a thought experiment that leads to a qualitative irreversible state of some object - the very same Schrödinger's cat, alive or dead—for two ways of synchronizing time.

The first case is completely based on the time synchronization that is used in SRT, and the essence of which is described in all popular books on SRT [3, 4], the second case uses a different synchronization, prepared in advance, imitating instantaneous long-range action, which, we dare to assume, takes place during the collapse of the wave function entangled quantum states.

The second case will lead us to a new paradox of simultaneity in SRT, in which one and the same Schrödinger's cat will be alive in one inertial frame of reference and dead in another.

The first cat thought experiment in the article, banal from textbooks, refers to an experiment with reality, or what we consider to be objective physical reality. Since clock synchronization is indistinguishably connected with the physical process - the propagation of light in a vacuum. Time-I [1, 2] is identified with the way it is measured. There is no problem here.

The second thought experiment with a cat (his second death), outwardly indistinguishable from the first, is already an experiment on what we call consciousness (not with the human mentality, but with something more fundamental). Here, time-I is identified with the "knowledge" of the properties of two clocks, exactly as in SRT everyone knows ("we know") about the constancy of the speed of light in all IFRs. And this is where reality splits. The cat is both

alive and dead. Truly and simultaneously in both cases, without any quantum superposition.

The second thought experiment is also based on the fact that, as Christian Marchal showed in 1998 [5], the Lorentz transformation is derived directly from the principle of relativity and the symmetries of transformations without postulating the constancy of the speed of light. That is, all relativistic effects can be justified from purely logical positions, without invoking the "objectivity" of the physical properties of the world.

The significance of the constancy of the speed of light lies not in the "objective" properties of the electromagnetic field, but in the fact that each observer in different inertial systems must interpret time as duration in the same way. This is possible when all systems have a single standard for converting elusive time duration into spatial duration (i.e., into a visually represented length — we know of no other). That is, in all inertial systems, the conversion of time duration into spatial length must be the same and linear. Spatial distance (S) should be considered as the product of a constant (C) and units of the time scale for a certain reference process (S = C t). In our world, this reference process is the propagation of electromagnetic waves in a vacuum.

Here lies the connection between the need for objectivity in the "material" world and the need for consciousness as logical forms.

The justification for this paradox will not be the prejudices of modern physics about the immediate reality of observation, which I reject in the second case, choosing a different way of synchronizing the clocks, but only the tools exclusively associated with the consciousness of our observing Self, i.e. pure logic. Therefore, the paradox of simultaneity is a logical paradox. The paradox limits one of the SRT conclusions – there is no absolute time. SRT only gives grounds for the following statement - **there is no absolute scale of the duration of physical processes based on the same physical processes** - and not Time in general.

2 The paradox of simultaneity in SRT, from generally accepted principles

So, two observers A and B decided to execute Schrödinger's cat K in a rather convoluted way. Next to the cat K, they put a light source (synchronizer), which simultaneously emits

a light pulse to the left and right sides, where more powerful pulsed light sources are located at an equal distance L - left S_l and right S_r, emitting their radiation towards the cat by a light signal from the synchronizer.

Radiation from sources S has a specific property if both impulses reached the cat at the same time - the cat K died if there was even the slightest non-simultaneity in the events of reaching the cat by the left and right impulses the cat remained alive.

Both observers adjusted the equipment and conducted a successful control experiment with a test cat K, we will assume that the supply of Schrödinger's cats is not limited. The cat died (Fig 1)

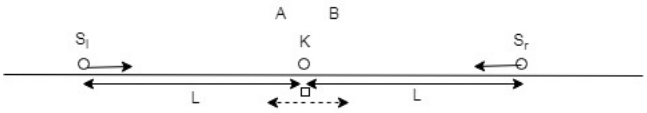

Figure 1:

Indeed, during the start of the experiment, we will choose the time of the flash of the synchronizer next to the cat t = 0. After the start time of the sources t_1 = L / c (c is the speed of light), the sources S will work, and after the time when the cat reaches t_2 = L / c, the cat K will die, since the installation is completely symmetric with respect to the cat and $t_1^l = t_1^r$, as well as $t_2^l = t_2^r$.

$$t_1^l + t_2^l = t_1^r + t_2^r$$

The test cat was removed, replaced by the next one, but only one observer A remained next to K, and the second observer B moved a sufficient distance to the left, and began to move uniformly from left to right at a speed V.

From his point of view, the entire system with the observer A and the cat K moves towards him from right to left at a speed V, as shown in Fig. 2.

Observer B sees the same system, but with its own dimensions L' in his frame of reference, which does not qualitatively change the situation - the distances to the sources S to the left and to the right of the cat in the observer B's frame will still remain equal.

What does observer B see?

At the moment of synchronizer operation (t = 0 we will take it as the origin and in system B) the synchronizer pulse will catch up with the left source with a speed c - V, and go towards

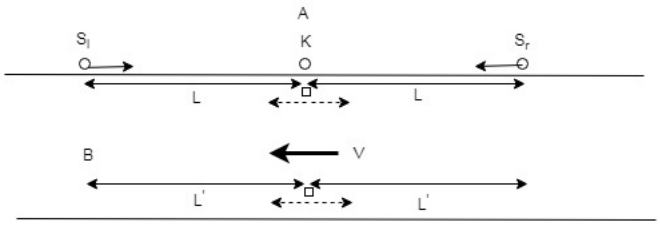

Figure 2:

the right source with a speed c + V, here we use the SRT postulate that $c = const$ in all inertial reference systems. That $c + V > c$ is admissible, since this is not the speed of a material point, but the speed of convergence of the synchronizer pulse with the source S_r.

For observer B, the starting time of the left source is $t_1^l = L'/(c - V)$, and the starting time of the right source $t_1^r = L'/(c + V)$, i.e. the right source S for observer B will start working earlier than the left one, and not simultaneously, as for observer A.

When the S sources are triggered, on the contrary, the beam of the left source will go towards the cat K, flying at it with a speed of V, and the beam of the right one will catch up with the cat K moving away with the same speed.

Therefore, for observer B, the times for the cat to reach the deadly impulses will be as follows -

$$t_2^l = L'/(c + V), t_2^r = L'/(c - V)$$

But for observer B, the equality $t_1^l + t_2^l = t_1^r + t_2^r$ will still hold, which means the death of the cat for observer B.

As a result, both observer A and observer B will see the same dead cat. Here in SRT everything will be agreed on the qualitative state of the test object K.

But our observers decided to change the execution device for Schrödinger's cat. They abandoned the light synchronizer near the cat and took instead two (T_1 and T_2) synchronized clocks, we will count with zero discrepancy, because we have a mental experiment. Each clock was placed at the sources S, and as soon as the time t = 0 occurs on both clocks with some periodicity (we now count it as the beginning of synchronization in the experiment) they start each of their sources S, as shown in Fig. 3.

Both of our observers conducted a series of experiments, not sparing cats, and made sure

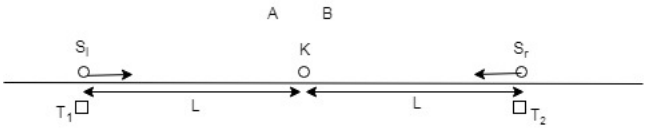

Figure 3:

that the system is fully synchronized. Cats die because the start times of the sources S – $t_1^l = t_1^r = 0$ (simultaneous start is achieved, simulating instant interaction, as if one source always "knows" that the other is also launched together with it). And the times of reaching the impulse from S to the cat K are equal to each other $t_2^l = t_2^r = L/c$, so that the condition for the execution of the cat $t_1^l + t_2^l = t_1^r + t_2^r$ is always fulfilled.

Again, after placing another still alive cat on the place of execution, observer B retired a sufficient distance to the left, and began to move uniformly from left to right at a speed of V. Or, from his point of view, the whole system with observer A moves towards him from right to left at the same speed V as shown in Fig 4.

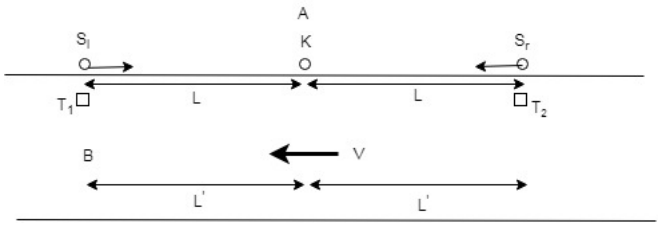

Figure 4:

At the moment of time t = 0 of the beginning of the experiment, which is also the moment of synchronization of the sources S, observer B sees that the left source has worked. From previous joint experiments with observer A, he KNOWS that at the same moment the right source S also worked. He has no reason to believe that the right source worked earlier or later than the left one. Observer B performed all operations during removal - reversal, acceleration, stabilization of motion for both the left and the right source S.

It is logically impossible to refer to the time shift along the coordinate in the Lorentz transformations, equal to $-\frac{vx}{c^2\sqrt{1-\beta^2}}$, because it is a direct consequence of

the synchronization of clocks with the help of light (c), and we have excluded this from our consideration. Assuming this shift in time, we simply again implicitly put a synchronizing light in the middle, as in the previous case. But we mentally eliminated this source.

Therefore, there is no asymmetry during acceleration, as in the case of the explanation of the paradox of twins, it was equally accelerated and decelerated for both sources. S. Therefore, as in the frame of reference of the observer A, for the observer B, the synchronization times are zero $t_1^l = t_1^r = 0$.

But the times of reaching the cat K of the impulses of the right and left sources S will be different, taking into account the same SRT postulate - $c = const$ for all inertial reference systems.

Moreover, we do not need to insist on the last statement (for all) - no matter what the speed of light is in different frames of reference, in our case this will not affect the conclusion. The main thing is that the speed of light does not depend on the direction of propagation of light.

The impulse of the left source will fly towards the cat at a speed of c + V, and the impulse of the right source will catch up with the cat moving away from it at a speed c-V. Therefore, $t_2^l = L'/(c+V)$, and $t_2^r = L'/(c-V)$.

As a result, for observer B, the cat's death condition will not be met

$$t_1^l + t_2^l \neq t_1^r + t_2^r$$

For observer B, the left impulse will reach the cat earlier than the right one, the condition of simultaneity in the observer B's system will not be met and the cat K will remain alive, while in the observer A's system the same cat must die, because in this system, the right and left impulses, under the supervision of A, reached the same cat at the same time !!

This is the new paradox of simultaneity in SRT.

So which cat is actually dead, as in the system of observer A, or alive, as in the system of observer B? And what is "really"?

3 Supplement for physicists. Questions for reflection

"Really" is a hidden postulate that the existing laws of physics do not depend in their content on the consciousness and actions of human interpretations of the experiment. What we call the objectivity of the material world.

But is this "objectivity" independent of consciousness?

What makes in the first experiment in a moving inertial frame some clocks start before others so that no paradox is observed? A synchronizing light source standing exactly in the middle of them, plus Einstein's postulate about the invariance of the speed of light. The light pulse itself.

Let's remove this synchronization source in the middle of two hours. By synchronizing the clocks in their rest system, and making them emit **autonomously and simultaneously** impulses of light. According to Einstein's theory, nothing qualitative will change in the experiment. Clocks in a moving inertial frame of reference will again emit impulses non-simultaneously so that no paradox with cats will arise. But what replaces in this case **quite material** pulses of light of the synchronizer removed from the experiment?

Large-scale changes (Lorentz transformations) in the structure of space-time (and this is a mental tool - no one directly observed a four-dimensional ball). Those in fact, **some of our mental representation of the world**, confirmed by numerous experiments organized in accordance with Einstein's theory, assuming the truth of Maxwell's equations and exactly the way we have been taught this all our lives.

Thus, **the material impulse of light will replace the mental mechanism**, a product

of our consciousness trained in a certain way in our universities. Because there is simply no place for any compensatory physical processes to come from. We simply removed the synchronizer, which is unnecessary for a stand-alone watch.

Let's move on to the second experiment with the cat.

What will force the clock in the second experiment in the moving inertial system to work simultaneously, as well as in the resting system of clocks? This creates a paradox.

The absence of any preferences and differences between the two clocks (they are also sources of light pulses), since the second synchronization method takes out of brackets the Lorentz transformations, which are identical, in our case, to the eliminated light source in the middle of the clock.

We forget for a while (how to do this is not at all an easy and very interesting task!!) that we were taught at universities and rely only on pure logic.

Those **also our mental (logical) idea of the experiment** with the introduced new clock synchronization conditions and, consequently, with a different interpretation of time.

The power of non-difference (insufficiency of arguments) in logic is called **the principle of sufficient reason**.

This principle is that mighty force that makes the clock, contrary to Einstein's theory, in our thought experiment work simultaneously in a moving frame of reference.

The same principle underlies the theory of probability, it is thanks to it that the probability of any face of a "fair die" falling out is 1/6. We cannot find any other argument for a uniformly distributed probability.

And this mental force, I believe, lies at the heart of the second law of thermodynamics.

As a result, we found out that in both cases (in Einstein's theory and in my thought experiment) behind the lives of Schrödinger's cat are representations of our consciousness, its attitudes towards certain ways of interpreting "time". **And these representations are an integral part of "objective reality"**.

It remains only in the experiment to carry out that interesting task of forgetting "what we were taught in universities" (very difficult), and we will see in reality a new connection between consciousness and reality, expressed in random outcomes of experiments with cats at the macro level. Those what we encounter in the quantum world.

The basis for such a hypothetical assumption is a heuristic comparison: the fact that "time" in quantum measurement - the collapse of the wave function, the von Neumann reduction - is not any process, but only a point of instantaneous perception.

Just as in the second experiment with the cat, the autonomously synchronized clock "imitation" (?) instantaneous long-range action.

Moreover, "imitation" has the meaning of imitation only from the point of view of scientific prejudices about time as exclusively the duration of any process.

For a third-party consciousness, not burdened with this prejudice, in the second experiment with a cat, the long-range action of synchronized clocks is quite a "real fact".

And most importantly, there is no "time" outside of consciousness, and vice versa, it is impossible to logically think purely. Since any interpretation, or even an attempt at it, of one or another of these concepts necessarily carries out its action of interpretation both in time and in consciousness.

If in this there are doubts, try to carry them out either out of time or out of consciousness.

Key idea of the article - the interpretation of time in the form of duration of a reference physical process (propagation of light in a vacuum) or in the form of an instantaneous perception of a measurement (as in the collapse of the wave function of a quantum state).

Time is not only duration, but also the beginning and end of duration. Without these two points of perception, time is meaningless.

Duration and points of perception of time (both concepts are intuitive and demonstrative-doxic in nature [1], like time itself) constitute its integral structure, which cannot but manifest itself in the laws of nature.

In the macroworld as duration, in the quantum world as points of perception.

The interpretation of time is not only a mental action (not words), but also an experimental one.

4 Conclusion

There are logical reasons to believe that the outcomes of certain physical experiments depend on the implementation in them, directly or indirectly, of actions interpreting physical "time" in two forms. In the form of the duration of some reference physical process or in the form of an instantaneous perception of measurement.

Besides, if we take into account the non-locality of quantum states, experimentally proved when checking Bell's inequality (Nobel Prize 2022), then this logical paradox gives all grounds to consider the "terrible long-range interaction" (A. Einstein) as a real, not abstract, property of the physical world. A property concerning that side of reality that we call consciousness.

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